SCIENCE

VOL. 74 FRIDAY, JULY 24, 1931 No. 1908

The Metals in Electrochemistry: PROFESSOR LOUIS KAHLENBERG 79

Some Remarks on Mathematical Statistics: PROFESSOR H. L. RIETZ 82

Obituary:
Dr. Stephen Moulton Babcock: PROFESSOR H. L. RUSSELL. PRESIDENT GLENN FRANK. *Recent Deaths* 86

Scientific Events:
The Royal Botanic Society; Expenditures of the U. S. Public Health Service; Research Foundation of the University of Wisconsin; The Lamme Medal; Summer Work of the Botanists of Harvard University 88

Scientific Notes and News 91

Discussion:
The Basic Sciences at the Chicago Centennial Exposition, 1933: COLONEL JOHN S. SEWELL, *The Work of Chinese Botanists on the Flora of China:* DR. E. D. MERRILL. *Exponents and Footnotes:* DR. F. B. SUMNER. *Color:* PROFESSOR W. A. NOYES 94

Special Correspondence:
Grants-in-aid of the National Research Council: DR. VERNON KELLOGG 96

Societies and Meetings:
The Texas Academy of Science: H. B. PARKS. *The New Hampshire Academy of Science:* PROFESSOR GEO. W. WHITE 97

Scientific Apparatus and Laboratory Methods:
A Simple Grinder for Soft Tissues: DR. CARL TENBROECK. *A Simple Apparatus for Washing Protozoa:* DR. JOHN P. TURNER 98

Special Articles:
X-Radiation and Regeneration in Amblystoma: PROFESSOR ELMER G. BUTLER. *Effects on the Gonads of Cortico-adrenal Extract:* DR. E. L. COREY and DR. S. W. BRITTON. *Antiurease:* DR. JAMES B. SUMNER and J. STANLEY KIRK 100

Science News 10

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE METALS IN ELECTROCHEMISTRY[1]

By Professor LOUIS KAHLENBERG

UNIVERSITY OF WISCONSIN

ABOUT two thirds of the chemical elements recognized at present are metals. Of these seven, namely, copper, gold, iron, lead, mercury, silver and tin, have been known since prehistoric times. Antimony and bismuth were discovered by Basil Valentine in 1450; zinc by Paracelsus in 1520; and arsenic by Schroeder in 1694. In the latter half of the eighteenth century ten metals were discovered, namely, chromium 1797, cobalt 1773, manganese 1774, molybdenum 1782, nickel 1751, platinum 1741, tellurium 1782, titanium 1789, tungsten 1781 and uranium 1789. During the nineteenth century about forty-two new metals were discovered. Of these forty-two metals, about twenty-six were reported before 1850, and the remaining sixteen were recognized during the latter half of the century—fourteen of them being isolated before 1890. Radium and lutecium were discovered in the twentieth century.

Thus most of our metals were discovered in the nineteenth century, particularly during the first half of that period, and during the three decades from 1860 to 1890. The reason for this lies mainly in the fact that electrolysis came into use with the electrolytic decomposition of water effected by Nicholson and Carlisle in 1800, and the introduction of practical spectroscopy by Bunsen and Kirchhoff in 1860. Electrolysis and spectroscopy, then, have greatly increased the number of metals (and also other elements) that we now know. Indeed, the finding of another new metal was so common during the nineteenth century that such discoveries almost became monotonous. To be sure new elements have also been found by purely chemical means; that is to say, without electrolysis or spectroscopy. Moreover, the

[1] Presidential address at the meeting of the Electrochemical Society, Birmingham, Alabama, April 24, 1931.

periodic system of the elements as promulgated by Dimitri Mendelejew and Lothar Meyer suggested the existence of new hitherto unknown metals which were very soon found. Furthermore, the discovery of radium in the present century has resulted in finding other elements that are radioactive. In fact the pursuit of radioactivity has rivaled in intensity the efforts directed toward spectroscopy which date back to the latter half of the preceding century.

Now, while the metals are numerous, it is nevertheless true that the atmosphere and the great bulk of the oceans and the lithosphere as we know them are non-metallic, consisting largely of oxygen, hydrogen, nitrogen and silicon, though to be sure the latter has certain metallic qualities. It has been estimated by F. W. Clarke that aluminum, the most abundant metal in the lithosphere, is present to the extent of 7.90 per cent.; and iron which is next in order to the extent of 4.43 per cent.; calcium, magnesium, sodium and potassium forming 3.44, 2.40, 2.43 and 2.45 per cent. of the earth's crust respectively. All other metals and non-metals constitute only a few tenths, and in most cases only a few hundredths, of a per cent. of the earth's crust.

Thus far the metals have played a special rôle in the development of electrochemistry, for they all conduct electricity and they are liberated from their compounds by electrolysis. The latter fact caused Sir Humphry Davy to formulate the first electrochemical theory, which was to the effect that chemical affinity is in reality electrical attraction. Much was made of this view, and the dualistic theory of Berzelius held sway for half a century. In fact, dualism has by no means disappeared from our science. The Arrhenius theory carries with it the essentials of dualism; and, indeed, the present much-heralded hypothesis that all matter is made up of protons and electrons is also dualistic in character. The notion that electricity is material came from the intensive study of Sir Joseph J. Thomson on the discharge of electricity through gases.

Though the idea of the atom dates back to ancient Greece, our present atomic theory, which has held sway for a century and a half, is founded upon the laws of stoichiometry; and our molecular theory has grown out of the law of Gay-Lussac of the combination of gases by volume. So useful have the atomic and molecular conceptions been, and so intensively have they been preached and advocated, that it is almost dangerous to remind people that atoms and molecules are after all only theoretical entities. How many persons actually know that we write the formula of water H_2O instead of HO simply because we want to hold Avogadro's hypothesis? How many actually know that the molecule of hydrogen is written H_2 simply because we want to hold Avogadro's hypothesis? Yet such hypothetical things, valuable though they be, are continually being regarded as actual facts, an attitude which can only retard true progress.

In the nineteenth century the physicists tacitly and even gladly accepted the chemical atoms and molecules founded upon the laws of combination by weight, and by volume in the case of gases. The physicists used the atomic and molecular conceptions in connection with their studies of electricity, heat, light and radiant phenomena with the result that now in the twentieth century they have concluded that the chemical atom is complex and made up of protons and electrons; *i.e.*, electrical particles or corpuscles much smaller than the atoms, whose so-called structure must consequently be studied. The idea that electricity is material in character and that it is the primordial matter out of which our so-called chemical elements are composed has naturally opened up the old question of the transmutation of the elements and particularly the transmutation of the metals. Indeed, observed transmutations have been reported as going on during the process of the decay of radioactive bodies, and thus the old dream of the alchemists has been renewed. While such observations have been reported as going on spontaneously, transmutations effected in the laboratory are lacking. We still get our lead from the Ozarks.

In the study of the metals much has rightfully been made of the fact that the atmosphere surrounding a red-hot metal conducts electricity. The explanation that this is due to electrical particles flying off from the hot metal recalls the old idea of phlogiston, a subtle material which was supposed to leave the metal when it was heated or burned. The phlogistic theory was overthrown by the results obtained by exact experiments with the balance. Nevertheless, this revolution was not accomplished without a hard fight, and it should now be recalled that experimenters of the first order like Cavendish, Scheele and Priestley never relinquished the idea of phlogiston. Now, indeed, what is essentially this same notion is again coming into the foreground under the name of the electronic theory, albeit it is now founded upon an array of experimental data, whereas a hundred and fifty years ago it was largely speculative in character, being based merely upon qualitative observations which were readily discounted in favor of the views of Lavoisier and his followers, who presented exact quantitative data, representing careful weighings, to substantiate their view of combustion.

The balance has had its innings for nearly a century and a half. While the work with the balance was fundamental and important and also inaugurated

quantitative experimentation instead of qualitative or quasi-quantitative observations, nevertheless we are now coming to recognize that by no means everything is amenable to study with a balance. In other words, we are gradually emancipating ourselves from the tyranny of the balance. The old romantic spirit of phlogistic times is coming back. It was, indeed, kept alive by the discovery of Dulong and Petit that the heat capacity of the atoms is essentially the same, by Dr. Seebeck's famous discovery of thermo-couples, by Faraday's discovery that chemically equivalent quantities are deposited by the same current, by the thermochemical work of Julius Thomsen and Marcelin Berthelot, by the discovery of Wiedemann and Franz that heat conductance and electrical conductance go hand in hand, by the brilliant work of Bunsen and Kirchhoff on the spectra of the elements, by Crookes' experiments in vacuum tubes, by the x-ray work of Roentgen, and by the radioactive studies of Madam Curie. The fundamental researches of Volta on the contact potentials of the metals and his discovery of how to pile up E.M.F. by connecting batteries in series are specially memorable. They inspired the later work of Kelvin, who measured the potentials of the various metals against his standard gold plate.

For a number of years it has been my privilege to report to this society the results of my researches on the electrochemical series of the metals, the potentials developed by the latter in various electrolytes and the replacing power which the metals exhibit toward one another. Recently the potentials developed by metals laden with gases came into consideration in these researches. All these experiments, and especially the last work on gas electrodes, have convinced me that the effects observed are due principally to the metals and their specific nature, and secondarily due to the electrolytes and gases with which the metals are in contact. This conclusion is in line with the idea expressed by Volta, by Kelvin, and, indeed, even by Nernst when in his theory of contact potential he endows the metals with a specific so-called solution tension.

Theoretically, it should be possible to deposit electrolytically any and all of the chemical elements; there is no limit as to the possibility of forming chemical compounds, both inorganic and organic, by means of the electric current or electric contrivances. In practice, we have developed rather slowly in these matters in recent years. We have been hampered because it has been difficult to find the suitable electrolyte, suitable electrodes, and also the proper conditions of temperature, potentials impressed and current densities to accomplish the purpose in hand. To be sure, in many ways enormous strides have been made in our electrochemical industries. It is not the purpose to rehearse these here. We are plating with chromium now. How to plate with tungsten will be told us at this meeting and perhaps ere long we shall learn how to plate with silicon or even with boron. Yet these are minor details as compared with the great problem of gaining a better understanding of the fundamental nature of the metallic state itself. What is it that gives metals their peculiar and highly specialized character? Why do they conduct electricity? Why are they ductile and malleable and strong in some cases and not in others? Why are they all opaque? Why are they silvery white to steel gray in hue with the sole exceptions of the two colored metals—gold and copper? Why are some of the metals so intensely poisonous to plants and animals and others not? Why are some of the metals so absolutely necessary in considerable quantities in life processes and others not? These and many other questions suggest themselves and must eventually be answered.

The great problem to-day is not to find more new metals, but rather to reduce the present number by showing that they are complex, that they can actually be resolved into something simpler, and that they can be synthesized in actual practice. In this work our present atomic theory, founded as it is upon the weight relations that obtain in chemical combinations, will probably avail us little or nothing. In fact the intensive efforts at unravelling the so-called atomic structure of the elements by means of miniature astronomical models, while interesting, are entirely too significant and do not suggest how to proceed experimentally to accomplish the proposed task. New and novel experimental methods of inquiry must be found. This is the order of the day. Are we of the twentieth century to sit by and try to solve our problems at the writing desk by means of models and equations which start from fixed assumptions and preconceived notions that have ever been recognized as the chief bar to scientific progress? Or are we to go into the laboratory and workshop unhampered mentally and once more guided by the inspiration of the spirit of the great experimental geniuses of the past, using the far superior experimental means at our command, seek to find entirely new and novel ways of approaching the problem of the riddle of the metals? Once this is solved, it will doubtless carry with it the solution of many other fundamental questions. One who continually works with the metals in the chemical and physical laboratories can hardly divest himself of the idea that there is something fundamental which the metals have in common that has thus far entirely escaped us.

The most promising line of experimentation before us at the present time seems to lie in the study of

the phenomena in high vacua, in the photoelectric investigations, in the systematic inquiry into thermoelectric and radioelectric effects, and in alternating current rectifiers. Naturally great experimental difficulties are encountered in inquiries of this kind and these are augmented by the inordinate desire to gain premature theoretical conceptions, especially mechanical conceptions of what takes place, when the phenomena in question are probably not at all amenable to explanations of this nature. We must learn to work by faith and inspiration. We must learn again to divine the truth. We must be led as such geniuses as Davy and Faraday were led in their experimental inquiries. What guided them in their fundamental discoveries was a species of intuition, and not complex mechanical theoretical conceptions made still more obstruse by intricate, yet nevertheless quite inadequate, mathematical equations and expressions. Theories have their place. They are useful but they must not be taken too seriously. They must not be believed too hard lest they enslave us and bind us to earth. It is highly desirable to keep the minds and spirits of our younger generation free and unhampered by too serious consideration of theoretical conceptions with which present-day scientific literature overabounds. Rather a jovial, happy-go-lucky spirit of experimentation is to be cultivated, for as the great poet Goethe has put it—"Grau teurer Freund ist alle Theorie und grün des Lebens goldener Baum."

In this spirit and in this sense our efforts toward opening new avenues of inquiry by stimulating novel ways of experimentation that are calculated to reveal undreamt of vistas, our society has established its new division of electronics and paralleled the same with electrothermics and electro-deposition. May this new field prove specially fruitful, may it provoke thought and discussion and yield experimental results of a basal character that shall call for additional, novel divisions of our society so that the ends for which it was founded may truly be realized.

SOME REMARKS ON MATHEMATICAL STATISTICS[1]

By Professor H. L. RIETZ
UNIVERSITY OF IOWA

IN casting about for a favorite topic on which to address you on this occasion, I was anxious to give much weight to your feelings as to what would be most appropriate considering both your interests and my limitations. It seemed fairly obvious that you would wish me to speak on a subject of which I have some special knowledge and to which I have made at least a few contributions. These conditions determined the general field in which to select a topic. In spite of these great limitations I wrote down a dozen or more specific topics, but finally selected a subject so broad that it leaves plenty of room for suitable limitations as we proceed. In this way it has come about that I am to make some remarks on mathematical statistics. Although much that I shall say may be an old story to many of you, I shall find something of a child's delight in "saying it again" if I can say it in such a manner as to interest you.

The statistician engaged in the collection of data has sometimes been pictured, like Sam Johnson's maker of dictionaries, as the slave of science doomed only to gather together the material with which others build and press forward to conquest and glory. While this picture may portray a modicum of truth, my experience of over twenty years in the examination of data obtained from a great variety of sources leads me to think that the genuine collector of material ordinarily enjoys the process of collecting more than he would enjoy the more difficult thinking involved in the analysis and interpretation of the data. The analysis of available data often lags far behind the process of collection, particularly in cases of organized research. It is in the process of analysis that mathematical statistics has become, to a very considerable extent, the servant of science.

The publication of the "Théorie Analytique des Probabilités" of Laplace in 1812 marked the culmination of the first great period of activity in the development of the principles underlying mathematical statistics. In fact, the publication of this monumental work of Laplace practically closed the first great epoch of the development of these principles; for, following this publication, relatively few outstanding results or central theorems of mathematical statistics were contributed until our current period of activity which started in the decade 1890 to 1900, with the development of generalized frequency curves and a theory of correlation. To be sure the DeMoivre-Laplace law of error was developed by Gauss and given its important place in the adjustment of observations, but there was, on the whole, relatively little progress.

The activity of the decade 1890 to 1900 may be properly regarded as the inauguration of the second great epoch in the development of mathematical statistics. As early as 1895 the fact had become

[1] Presidential address before the Iowa Academy of Science, May 1, 1931.

fairly well established from the analysis of frequency distributions of very excellent anthropological and biological data that the Gaussian or normal probability curve is inadequate to represent many important frequency distributions. When the problem of developing generalized frequency curves was finally attacked, the attack was made from several different directions. Thiele and Charlier in Scandinavian countries, Pearson and Edgeworth in England, Fechner and Bruns in Germany developed theories of generalized frequency curves from very different view-points.

As a result of these different view-points, there have been developed several different systems of frequency curves. While any expression of preference for a pet system of frequency curves is likely to lead to controversy, I shall have the temerity to say that the Pearson system holds first place and that it and the Gram-Charlier system have been used to such an extent that they may, from certain points of view, be fairly regarded as the major systems, whereas the translation system of Edgeworth, the transformation system of Kapteyn, the logarithmic normal curve and others may be regarded as minor systems.

Pearson provided at first four types of curves, then increased the number to seven and finally in 1916 to twelve. We have two types in the Gram-Charlier system. However, the latter system involves infinite series and might on this account be regarded as consisting of many types. We not infrequently hear the question, What is the primary object of generalized frequency curves which seem rather complicated to many scientists and non-mathematical statisticians? My answer is first that the development of generalized frequency curves from plausible underlying laws of probability represents the results of the desire of the human mind to produce a sort of theoretical norms to serve as models for describing and analyzing both observed frequency distributions, and the expected distributions of results from repeated observations. Next, the type of frequency curve that will fit an observed distribution is likely to suggest appropriate assumptions for a mathematical treatment. Finally, it seems that to seek the laws of distribution of statistics is the outgrowth of a natural movement to which a distinguished botanist, the late Professor J. Arthur Harris, aptly directed attention in the following words of an address given a short time before his death: "Apparently all the physical and biological sciences move in their development toward a final period, not yet surpassed in any of the sciences, of mathematical description and analysis, and of the formulation of mathematical laws."

We turn next to a brief mention of the development of the theory of correlation. In mathematics, the bulk of our work and energy in the study of relations has been put into the consideration of very precise relations known as functional relations. Thus, we have given much consideration to situations in which x and y are so related that when x is given, y can be calculated or is at least determined. A fair amount of energy has also been put into the consideration of the association of elements under the assumption that they are independent in the probability sense of independence. We thus consider, in the main, what may be called cases of perfect dependence at one extreme and of perfect independence at the other. Such mathematical concepts have served very well the needs of a wide range of physical applications. But a new kind of mathematical concept was needed to deal with the region between the two extremes. In this intermediate region there lies apparently a large field of investigation that I may perhaps appropriately call the field of correlation theory. In the usual field of mathematical relations, the primary question is: given an assigned x what corresponding value of y is determined? In this new field the corresponding question is: given an assigned x, what is the probability that the corresponding y will take a prescribed value, or what are the probabilities that y will take any one or more of a certain prescribed set of values?

Correlation theory was early extended to deal with n variables in correspondence where n is any positive integer. The geometry of this situation has led into space of $n+1$ dimensions, and has served to illustrate Karl Pearson's remark that a knowledge of space of four or more dimensions is essential to an exact study of the diseases of defective children.

Many of the formulas of correlation theory are identical with the formulas of hyperspherical geometry. In this connection let me recall to you the address of Professor Dunham Jackson before this Academy three years ago in which he gave an elegant exposition of correlation by appealing to the geometry of n dimensions.

While I think I am appreciative of the usefulness and importance of the method of correlation, it is only frank to say that mathematicians are rather generally inclined to regard the method as having an empirical flavor. Although certain norms in the nature of mathematical functions suggested by laws of probability are involved in the theory, there is involved also a good deal in the line of curve fitting which has some resemblance to the fitting of empirical curves to data. The main purpose of one of my papers published about ten years ago under the title "Urn Schemata as a Basis for the Development of Correlation Theory" was to remove from correlation theory something of its empirical character. The suggestion of this development came from the fact

that the most fundamental theorems in the mathematics of statistics, say the Bernoulli theorem and the DeMoivre-Laplace theorem, are derived from urn schemata involving pure chance. In this connection it should be said that the late Professor Tschuprow, a Russian mathematician, took an important step in advance in his book on correlation published in 1925, towards connecting correlation analysis more closely with the abstract theory of probability.

We turn next to a brief consideration of recent progress in the solution of problems of random sampling. Most of our statistical investigations are in the nature of inquiries by taking a sample from a large and possibly infinite supply of material. To give a very simple illustration, we make a statistical inquiry about a characteristic of a whole class of men by taking a random sample of, say, 100, 1,000 or 10,000. Of course, this is not absolutely unlike the experimental procedure in the most exact sciences. Thus, the physicist and the chemist take small samples of a large supply of material. The difference lies in the degree of variability of the material. The individual items of the random samples taken by the statistician are often decidedly variable compared with the samples ordinarily taken by the physicist or the chemist. However, there seems to be no sharp line of distinction between statistical and non-statistical data. The data of the biologist are in many cases decidedly variable which is tantamount to saying the statistical elements are prominent.

A few years ago R. A. Fisher proposed the word "statistic"—the singular of the word "statistics"—for any result such as an average or an index calculated from a sample. We shall adopt this suggestion in the present paper, although the plural "statistics" in this sense is objectionable. A statistic varies from sample to sample. One of the main concerns of mathematical statistics is with the problems of variation and distribution of a given statistic. In attempting to draw inferences about the class of material from which a sample has been drawn by means of such a statistic as an arithmetic mean, a standard deviation, a correlation coefficient, or a regression coefficient, the essential inquiry is about the sampling fluctuations of the statistic, at least to the extent of knowing its probable error or some other appropriate measure of sampling fluctuations. Probable errors were first worked out for a few important statistics on the assumption that the distribution of a statistic would follow the normal probability curve. The problems were difficult even under this simple assumption. Student published in 1908 on the distribution of the ratio of the discrepancy of the mean of a sample from the mean of the population to the standard deviation of the sample drawn from a normal distribution. The distribution of this important ratio, which I call the Student ratio, has made it clear to statisticians that, with small samples, it is invalid to assume that almost any useful statistic is normally distributed. To carry the new knowledge about the distribution of the Student ratio into practical statistics, we now have a new probability table that should ordinarily be used by the practical statistician in place of the normal probability table in testing the significance of means obtained from rather small samples.

At the beginning of the present century, the exact knowledge of the distribution laws of statistics seems to have consisted in that of the arithmetic mean of items drawn from a normal distribution together with that of the mean-square for items from a normal distribution. Further than this, the distribution of the arithmetic mean for items from a uniform distribution was probably known. To this meager knowledge considerable has been contributed since the year 1900. In 1915 R. A. Fisher succeeded in giving the theoretical distribution of correlation coefficients obtained from samples of n-pairs drawn from normal distributions for any value n.

With the beginning made by Student in 1908, we have been for the past fifteen years in the period of unusual activity in attempts to find properties of the distribution laws of various important statistics. As a result of this activity we know a good deal about the nature of the distribution of the most important statistics for random samples drawn from a normal parent distribution. We know a little about distributions of a few statistics calculated from samples drawn from some very simple non-normal distributions; but, on the whole, we may say that large problems still await exact solution in cases in which the parent distribution is not normal.

In the foregoing remarks I have tried to give the main lines of a picture of some of the recent activities in mathematical statistics. As closing comments I wish to turn in another direction and submit for your consideration a few remarks on the place of statistical methods and views in science. In this connection I shall draw freely on certain views admirably expressed by Josiah Royce growing out of Maxwell's classification of the methods of science.

Maxwell recognized three main methods in science: The historical method, the mechanistic method and the statistical method. By the historical method science deals largely with individual events. An example of this method would be the scientific treatment of a comet by observations, or the classification and meaning of a geological specimen. By the mechanistic method, science deals mainly with invariant laws to which all events of a certain class conform, and when such laws exist, they can be used to compute and

predict future events. This method is concerned with the individual event in so far as it was predicted by the law. Thus, the mechanistic method is concerned with the exact prediction of the individual comet but this concern is very different from that involved in the historical view of the comet. The triumphs of mathematical astronomy, and of analytical mechanics, furnish some of our most striking examples of the success and satisfaction that go with the mechanistic view. No one has any doubt about the importance of the achievements resulting from this view.

In taking the statistical view, the main motive does not center about the individual event nor about the invariant law. Its concern centers about the average and probable constitution of a set of variable items and about the probability that this average will remain stable within certain limits of approximation. The world of the statistical view consists of individual items, but the main interest lies no longer in each individual item. The statistical view is concerned mainly with a set of items. It may turn out that the occurrences conform to a law, but the law sought by the statistical method is an account of the collection of events in terms of averages and probabilities.

Royce illustrated the way the statistical view contrasts with both the historical and mechanistic views by considering how each point of view applies to an event such as is expressed in the assertion: "A killed B." For a strictly historical point of view this event is a unique occurrence—possibly a free-will act. It falls under moral and criminal laws. For a strictly mechanistic view of things, the killing resembles the appearance of a comet which could have been predicted. Unique as it is, it is supposed to have been essentially predictable. The argument would perhaps run somewhat as follows: If you had known the precise configurations of all the physical particles in the world at some appropriate moment and the laws governing these particles then this killing could have been calculated in advance. It is a mere case of law—a point of some life line.

But from the statistical point of view the killing of B by A is an event against which insurance provision could have been made in advance—not because it could have been predicted that A would kill B, but rather because this individual occurrence could not have been predicted and because the death rate of men of B's age can be statistically calculated with approximate and probable accuracy, so as to make a policy insuring B's life a contract whose value is calculable, not on mechanistic but on statistical grounds. You might be interested in contrasting the views of life insurance under the statistical view with that under the mechanistic view. Under the mechanistic view, we should hold that except for our present ignorance of the physics, chemistry and mechanics of life, we could calculate and perhaps announce the date of each man's funeral at the time of his birth or earlier. All our life annuities would become annuities certain. This seems fanciful and somewhat ridiculous, but it would seem to be the logical consequence of making the mechanistic view the only view in science.

It seems to be a fact that the actual scientific knowledge of phenomena touching life most directly is, in the main, statistical knowledge. It is the sort of knowledge exemplified by mortality tables. This applies to what we know about heredity, birth, growth, behavior and death. It applies to economic processes and social transformations. Even if life be a mechanism, its phenomena are best known in terms of statistical averages and probabilities. Again the deeper knowledge of our most exact sciences seems to be pointing more and more to the conclusion that many fundamental problems of physics are statistical in nature. Thus, problems of atomic structure are regarded as statistical with the results stated in terms of probabilities. The individual electron does not seem to follow strictly determinate laws. We are told that either its location or its velocity remains in doubt. Its future motion can not be exactly determined, nor can its past motion be exactly given. This does not seem to be due to imperfect devices of observation and measurement, but to an inherent characteristic of matter. The principle of uncertainty in relation to either the position or the velocity of an electron is a statistical statement. It is fairly obvious that the influence of this principle of uncertainty is being felt in the philosophy of science. Perhaps some of you will recall in this connection a paper by Professor Warren Weaver in *The Scientific Monthly* for November, 1930, on "The Reign of Probability." His concluding sentence is that "the first part of the twentieth century (and we know not how much more) should be known as the reign of probability."

In considering the place of the statistical views in science, the question naturally arises: Is the statistical method in science simply a substitute for the mechanistic method or a last resort when the situation becomes so complicated that we give up making predictions about each individual item by any calculable process? It may seem so from a first impression of what has been said in this paper. Moreover, I think the statistical method is frequently in the nature of a last resort with regrets that we can not adopt the mechanistic view. However, I do not believe this description covers the ground reasonably if we should review the rationale of the whole situation. The statistical

method has a rationale of its own. In this connection, it may be well to recall that the validity of a proposition about physical phenomena under the mechanistic view at its best depends in the last analysis on verifications that usually involve errors of observations and approximate numerical computations. On account of such errors, we are unable to assert that the very exact proposition of the mechanistic view is literally true. On the other hand, we may be able to verify and assert in certain cases that the proposition in the statistical view is literally true, although it is a proposition about the probable and approximate. It thus seems to be a tenable position that the statistical view should not be regarded in all cases as a last resort.

In conclusion, the plausible inference is that along with our reverence for the mechanistic view and its achievements, it seems appropriate to recognize its limitations, and to develop also an appreciation for the rationale as well as for the convenience of the statistical view. However, it is not my intention to exaggerate the importance of the statistical view. In practice, it is usually the joining of statistical and mechanistic considerations that makes it possible to get workable results out of what appear on the surface to be weak and often meaningless relative frequencies and averages. The extensive analysis of data by improved statistical methods is a great step in advance, but such analysis will remain relatively sterile unless it is supplemented by the formulation of useful or interesting theories.

OBITUARY

STEPHEN MOULTON BABCOCK

WISCONSIN'S Grand Old Man is dead! The news has been flashed around the world that Stephen Moulton Babcock has closed his earthly labors. Working away daily with that patient, purposeful persistence that has characterized his assiduous labors for decades in his efforts to wrest from nature the mystery of the interrelations of energy and matter, to-night the busy mind is stilled. The laboratory that has afforded him the material vehicle through which his imagination played is silent. The pendulum that is so delicately adjusted that the doctor hoped he would be able to measure its variation in temperature as the weight swings to and fro will continue to vibrate until the mechanism runs down, but the hand of the master will no longer record its beat. The book was closed as he would have had it. The chapter was not finished, but a few days ago he added here and there a line, working away with undimmed enthusiasm that has been the marvel of his friends these many years. Rich in years that have been filled to the brim with new ideas that have kept his mind young and elastic, he has labored on and on. The joy of life to him was always the unsated quest.

Science is an exacting goddess. She brooks no rivals. He who would woo her and win must forego many of the allurements that detract the mind that generates new ideas. But to Babcock nothing could swerve him from his steadfact devotion to her cause.

The University of Wisconsin has had its share of really great men. Some have been great in the teaching field; some for their power of lucid statement through the spoken word that burned its way into the minds and hearts of men. Babcock was the scientist—the explorer who loved to push back the boundaries of the unknown. He knew no fatigue if any unsolved problem arose in his pathway. The joy of conquest appealed to him as it does to the finder of some undiscovered bourne, yet he would have hated to have been forced to organize his discoveries and reduce them to formal treatment. One thing he often said he never would do and that was to write a book.

The Spartan spirit of the pioneer marked his own method of research. He would not tolerate an assistant. Time after time Dean Henry, in the early days of the experiment station, would try to help him multiply his fingers through additional help, but it was of no avail. He would rather whittle out a piece of apparatus with his jack-knife (and the writer has seen many a piece so constructed) than to have a finely calibrated mechanically perfect device made for him in the machine shops. He used to say he could think better if he was using his own hands in fashioning the tools he needed.

Babcock lived in the right age to bring out the best that was in him. His pioneer spirit would fain spend but little time in poring over the writings of others to classify knowledge that already existed. He had but little regard for self-constituted authority. If a statement occurred in a book this was almost *prima facie* evidence that it had been borrowed from some other source; far too frequently, books masquerade in borrowed plumage. The laboratory, not the library, was where Babcock sought truth. He knew that nature would not lie, but he was never quite sure that man might not have erred in making the record.

Fortunately for Babcock, he had no graduate school to tie him down to Procrustean limits. I doubt whether he would ever have submitted to the exactions of a seminar. But those of us who have been fortunate enough to work where we caught now and then a glimpse of the movement of his scientific mind have indeed had a rare privilege. It was as if

an angel had touched our lips with a coal from off the altar.

Such contacts have meant everything to Wisconsin. For fifty years this spirit has moved among us. The Wisconsin Experiment Station has done a great work, and when all is said and done, the spirit of Babcock has been the pervasive power that has been imminent through it all.

It was Babcock's refusal to adopt the then prevalent notion that a completely balanced ration could be constructed on the basis of chemical analysis that led later here at Wisconsin to the epoch-making discoveries in the field of vitamin research and the rôle of mineral elements in the nutrition of animal life. While Babcock was a chemist, he was no such blind adherent to chemical methods that he lost sight of the fact that life was made up of something which could not be put into a test-tube.

Twenty-five years ago, Hart and his colleagues started their famous single ration diet for cattle, the results of which have made it necessary to rewrite almost wholly the text-books on nutrition, both as to the human as well as the animal. The germ of this suggestion came from Babcock's untrammeled mind. It was here that the torch was passed from the hand of the master to the pupil.

The world at large knows Babcock primarily for the beneficent invention of his famous test for butter fat, whereby the intrinsic value of milk could be easily and accurately determined. This came at a most opportune time and is one of the foundation stones on which the modern science of dairying has been built. Prior to this time, dairying was merely a haphazard art, but with this tool in hand the tremendous advance in the improvement of the special dairy breeds of cattle became possible.

The wide-spread utilization of the Babcock test made such unscrupulous practices as adulteration, watering and skimming the milk no longer profitable, because the test enabled such deceit to be quickly detected. As Governor Hoard once said the Babcock test had made more dairymen honest than had the Bible because of the summary verdict which it rendered.

Babcock's phenomenal grasp of the essentials of any problem to which he directed his attention is well shown by the remarkable contribution which he made in the field of physiology. His studies on "metabolic water," *i.e.*, liquids produced in the bodies of insects living upon perfectly dry matter made a new chapter in the physiology of metabolism. He bred clothes moths and carpet beetles, living on air-dry woolens and found that these animals could produce enough water as a result of their own life processes to bathe their body cells so that their normal functional activity could be carried on. From the standpoint of actual contribution to the advancement of science, Babcock always considered this his most important biological discovery.

It is impossible now to assign a proper value to his researches on the constitution of matter on which he has been laboring for almost two decades. He has been urged to give these results to the scientific world but characteristically he would not do so, because he did not feel that they were wholly complete. For the past twenty years, he has been working in his own way, reducing his ideas so far as he could to an experimental basis. During the past two years he has been very sanguine that he was going to be able to demonstrate in an experimental way some of the principles on which he has spent these years of thought and study. The record has been reduced to written form, and in his will this unpublished manuscript is to be given to the university. It is to be hoped that this work may soon be made available for the study of others.

To the world at large the name of Babcock will long be held in reverence, along with the great men that have left their impress on the minds of men, but the genial and jolly Babcock will always be the memory of those of us who were fortunate enough to have the privilege of actual association with him.

H. L. RUSSELL

ADDRESS GIVEN AT THE FUNERAL SERVICES IN MEMORY OF STEPHEN MOULTON BABCOCK

EXPRESSING the mood of myriads of men and women throughout the world, who have known the boon of his spirit or the beneficence of his science, the University of Wisconsin to-day bares its head and bows its heart before the memory of Stephen Moulton Babcock.

Inventor of a device and a formula that emancipated the dairy farmer from the injustice of the rule of thumb that long prevailed in the market place!

Trail blazer in the crucially important field of vitamin research!

Symbol of the best that the pursuit of science generates in the scholar and gives to the state!

Joyous comrade!

A friend beloved beyond measure!

Inspirer incomparable of the vast army of young scholars serving as acolytes at the altar of science!

Like the great seminal minds of the Renaissance, this grand old doctor of science was himself greater than anything he did, and thus, in death, he gives to us, the legatees of his spirit, a goal towards which to point the education and the science of our time.

This merry man of many years was made of the

stuff that gives mankind its saints and its martyrs. But he was a saint without seriousness, and he could have gone to martyrdom, without a murmur of self-pity, as part of the day's work.

For his was a casual greatness!

He pursued the most painstaking research as if he were playing a game. He brought to his tasks that gaiety of spirit which authentic greatness can afford. His spirit never surrendered that incorrigible playfulness which so often marks men of power. He brought laughter into the laboratory, for there was about him that deceptively careless air which creative spirits have as they go about their business.

But there was toughness to the fiber of his mind!

He was a teacher who scorned the tyranny of the text-books, and he did not think it impertinent to doubt the authorities. Each morning he met the universe with a question. His was the creative heresy of an insatiable curiosity. The cleansing winds of the critical spirit swept freely and forever through his mind.

He belongs to the apostolic succession of the great pioneers of research—Pythagoras, Aristotle, Archimedes, Copernicus, Galileo, Harvey, Newton, Lavoisier, Dalton, Faraday, Helmholtz, Darwin, Pasteur, Gregor Mendel and Einstein, for, like them, he was an adventurer into the unknown to whom research was an intellectual passion rather than an institutional ritual, to whom creative thinking was more important than elaborate equipment, and for whom there was no barricaded frontier between pure and applied science.

In an age when scholars all too often hasten to publish even before they prove their findings, he was content to let his greatest work speak for itself, for perhaps the most illuminating fact of his career is that he never published so much as a word about his part in the discovery, definition and defeat of that "hidden hunger" from which man and beast might die while eating their fill.

In an age smitten with the passion for publicity, he forgot himself into immortality!

And in the midst of the sickness of an acquisitive society, his spirit remained unsullied even by legitimate personal considerations!

Scholar of a great university!
Servant of a great state!
Shy benefactor of mankind everywhere!
Laughing saint of science!
Being dead he yet speaks!

GLENN FRANK
UNIVERSITY OF WISCONSIN

RECENT DEATHS

DR. DANIEL A. K. STEELE, dean of the College of Medicine and head of the department of surgery of the University of Illinois, from 1882 to 1917, died on July 19, aged seventy-nine years.

FREDERIC DUNN BELL, until last year chairman of the board of directors of the Lederle Antitoxin Laboratories of New York, and secretary of the New York Tuberculosis and Health Association, died on July 17.

MAJOR T. F. CHIPP, assistant director of the Botanical Gardens, Kew, died on June 28.

TRUMAN P. GAYLORD, vice-president of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania, formerly assistant professor of electrical engineering at the Armour Institute of Technology, died suddenly on July 5 at the age of sixty years.

HERBERT TOMLINSON, F.R.S., formerly principal of the South-Western Polytechnic at Chelsea, England, known for his work on the properties of matter, died on June 12 at the age of eighty-six years.

Nature reports the death on April 16 of Miss Anne L. Massy, known for her work on the pteropods and cephalopods.

SCIENTIFIC EVENTS

THE ROYAL BOTANIC SOCIETY

ACCORDING to a report in the London *Times*, numerous fellows of the Royal Botanic Society attended a recent meeting at the Royal Botanical Gardens to hear a statement which foreshadowed the dissolution of the society at the end of the year in consequence of the decision of the Treasury not to renew the lease of the gardens. While the break-up of the society in its present form seemed to be regarded as inevitable, hopes were expressed that the gardens might yet be preserved, and Colonel T. C. Moore, M.P., who has been in recent touch with Mr. Lansbury on the question, was co-opted a member of the council. The First Commissioner of Works, he said, had given him an undertaking that if any proposition could be made which would bring a more democratic influence to the gardens and yet make it possible to run them without loss it would be given favorable consideration.

Mr. C. C. Hoyer Millar, who presided, said that the lease of the gardens would expire on April 5 next year. He described the long struggle of the council to retain them, and expressed their deep regret that efforts to obtain a new lease had been of no

avail. Mr. Lansbury, while reminding them that the Treasury had decided several years ago that as all the various leases in the park expired, they were not to be renewed, was sympathetic, but said he failed to see how the decision could be reversed, though personally he would be glad if some arrangement might be made for the society's work to be continued.

There appeared to be no alternative but the dissolution of the society. Other sites outside London had been suggested, but the revenue had largely decreased since the Treasury's decision was made public, many fellows had resigned, and the depressing economic position and heavy taxation had caused the cessation of several important and remunerative functions. Expenditure had been curtailed as much as possible, but the fall in receipts made it impossible to cope with the position. Arrangements were being made to dispose of the stock of plants in the conservatories and houses, the contents of the library and museum, and the furniture in the fellows' rooms and offices.

In reply to a question about the present financial position of the society, the chairman said that they had £1,365 in the bank, and that expenses last year averaged £500 to £600 a month. They could not tell exactly how long they could carry on, but there was little chance of it being longer than December 31.

Colonel Moore outlined proposals for the retention of the society with fresh support from the public, a membership which would carry certain rights of admission to the gardens, a general charge of 3d. for the admission of the public, and the institution of two free days a week. He suggested that they should carry on to the end of the year and see that nothing was done to handicap the consideration of the proposed scheme. Mr. Greenwood, who for many years was the honorary treasurer of the society, regretted that Colonel Moore had not put his views before the council earlier, but said that if such a scheme as had been outlined could be carried out, all the fellows would be content.

EXPENDITURES OF THE U. S. PUBLIC HEALTH SERVICE

THE U. S. Public Health Service has expended in the drought states thus far $389,000 of the $2,000,000 drought relief health fund appropriated by the last Congress, according to a statement July 16 by the service.

In all probability this fund already has served to prevent serious outbreaks of disease in certain areas. The amount expended has been apportioned among 16 needy states, and allotments during the present fiscal year ending June 30, 1932, probably will be made to 20 states.

States in the dry area are doing their utmost to keep up their share of the expenses of maintaining health conditions in stricken districts, although many of them have been forced to obtain aid from the Federal Government. Numerous local health units probably would have been forced to suspend operations from lack of funds, if this help from the National Government had not been forthcoming.

The Public Health Service is using the utmost care in administering the $2,000,000 set aside for drought health relief. States calling for money are required to budget each item that they claim they need, and must show why they are asking for federal funds. Other Federal Government units have furnished information upon which the service partially has based its policies in administering the fund.

A total of $1,551,000 available for the fiscal year 1932 has been alloted to the states. This amount is what remains of the $2,000,000 fund less the money already expended, and less $60,000 for administrative expenses and a small reserve to meet extreme emergencies.

The amounts already expended in the states (A), the amounts allotted for distribution before the end of this fiscal year (B), and the totals for each state out of the entire drought relief fund (C) are as follows:

	A	B	C
Alabama	$ 15,295	$ 53,370	$ 68,665
Arkansas	74,155	155,916	230,071
Georgia	11,689	64,600	76,289
Illinois	16,719	48,405	65,124
Indiana	2,079	48,600	50,679
Kansas	.....	26,892	26,892
Kentucky	32,025	266,801	298,826
Louisiana	26,660	66,810	93,470
Mississippi	21,238	124,639	145,977
Missouri	21,295	138,900	160,195
Montana	2,790	10,000	12,790
North Carolina	.....	42,676	42,676
Oklahoma	20,201	75,680	95,881
Pennsylvania	25,343	16,379	41,722
Tennessee	56,278	89,247	145,525
Texas	22,733	130,266	152,999
Virginia	13,195	83,972	97,167
West Virginia	18,507	108,537	127,044
Total	$380,202	$1,551,690	$1,931,892

RESEARCH FOUNDATION OF THE UNIVERSITY OF WISCONSIN

THE Wisconsin Alumni Research Foundation has presented to the board of regents of the University of Wisconsin a report reviewing the results of its work during the first five years of its existence.

The foundation, the first of its kind inaugurated at a university, was incorporated on a non-profit sharing basis on November 14, 1925, and had as its

avowed purpose "to promote, encourage and aid scientific investigations and research at the university, and to assist in providing the means and machinery by which the scientific discoveries and inventions of the staff may be developed and patented, and their public and commercial uses determined."

It is pointed out that the methods pursued by the foundation have the advantage of securing patent protection and that the income from such patents is used for the support of research which is in general for the benefit of the public.

Starting with nothing more than the willingness of Dr. Harry Steenbock to turn over to the foundation an idea that was subject to patent in order to protect it from misuse, the organization already has earned an invested capital of $406,594, the income from which is now being used to protect its patents and for the public welfare through the furtherance of scientific research.

On June 1 of this year the foundation made use of its right to control the price of two of the products based on the Steenbock process by bringing about a 25 per cent. reduction in the price of these products to millions of consumers the world over.

Besides making possible these products, the discoveries of Professor Steenbock on the development of vitamin D in activating pharmaceutical and food products have been shown to be of material value to health, especially in the fortification of food intimately connected with the nutrition of the young, the health-giving properties of the process are now to be applied to the dairy field.

Holding that it is better to offer the discoverer some financial recognition for the large amount of work he had done, memorandum agreements were worked out by which, after all expenses had been repaid, 15 per cent. of the net proceeds from the patents go to the discoverer or inventor, while the remaining 85 per cent. is received by the foundation.

At the present time 11 patents or applications on discoveries made by university men are the property of the foundation. Most of these have been patented in nearly all the leading countries of the world.

Following three general principles for guidance in the allocation of funds for research, the foundation began to give aid to research during the fiscal year 1928–1929. To stimulate interest in the graduate body of the university, a lectureship in science was established, and at the same time aid was given to certain definite lines of scientific endeavor.

During the coming year, aid will be extended by the foundation to nine different projects in research. The sum of $21,500 for grants-in-aid to these different research projects has already been allocated by the foundation trustees.

THE LAMME MEDAL

IN 1920, Dr. T. C. Mendenhall, who was the first member elected to the original faculty of the Ohio State University, presented to the university a fund to provide for a medal to be called, in memory of a scientific friend of his early years, the Joseph Sullivant Medal. This medal is given once in five years to a graduate or faculty member who has "completed a really notable work in either the liberal, the fine or the mechanical arts, the pure or applied sciences, including the various branches of engineering." Mr. Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Company, a graduate in mechanical engineering of the class of 1888, was the first to receive this medal. The medal was presented at a special convocation at which Dr. Elihu Thomson made the principal address. Mr. Lamme is said to have been highly gratified to have on the stage with him Dr. Thomson and Dr. Mendenhall, the two men whose character and attainments had served as his ideals since his early college years.

His appreciation of the Sullivant Medal and his interest in engineers and engineering education caused Mr. Lamme to provide in his will for several medals and scholarships. One of the medals is given by the Society for the Promotion of Engineering Education for outstanding achievement in engineering teaching. A similar medal is given by the Ohio State University to a graduate of one of its technical departments for meritorious achievement in engineering.

The first presentation of this medal has already been announced in SCIENCE. It was made at the June convocation of the Ohio State University. Medals were given to Charles Edward Skinner, assistant director of engineering, Westinghouse Electric and Manufacturing Company, a graduate in mechanical engineering of the class of 1890, and to Arno Carl Fieldner, chief engineer, Experiment Stations Division, U. S. Bureau of Mines, a graduate in chemical engineering, class of 1906.

SUMMER WORK OF THE BOTANISTS OF HARVARD UNIVERSITY

PROFESSOR J. G. JACK expects to devote most of his time during the summer to the Arnold Arboretum, but a part of it may be required at the Harvard Biological Laboratory and Botanic Garden at Soledad, Cuba, where he spent the month of March. Alfred Rehder, curator of the Herbarium of the arboretum, who spent the summer of last year and of 1928 in various European herbaria, chiefly in the examination and photographing of types of plants of eastern Asia, will give most of his time this year to working out the results of these studies. Professor J. H. Faull will devote his research efforts in various parts

of eastern America to the diseases of spruces and poplars. Professor Karl Sax will continue plant breeding work. A considerable number of crosses have been made between different species of apples, cherries, lilacs and other ornamental trees and shrubs.

Professor I. W. Bailey, of the Bussey Institution, will spend the summer at the Biological Laboratory of the Carnegie Institution, Palo Alto, California. He has recently developed methods for removing tissue cells from trees, for keeping them alive and for studying them in the living condition. Professor E. M. East was at the Bussey Institution until July 15, carrying on investigations in the genetics of the genera Fragara, Nicotiana and Linaria. He now goes to the Jackson Memorial Laboratory at Bar Harbor, to prepare microscopical slides of hybrids in the genus Nicotiana. He also has under way experiments which seek to determine whether or not plants have immunological reactions comparable to those shown by animals.

In the department of botany, Professor E. C. Jeffrey will spend the summer collecting material for investigations on the relation of parthenogenesis to intimate processes in the cell. He will be in Cape Breton Island most of the time, gathering experimental and other material for this work. Professor W. H. Weston will remain in Cambridge most of the summer, engaged in research and keeping in close touch with the graduate students and National Research fellows, and Assistant Professor R. H. Wetmore and Dr. R. H. Woodworth will conduct the summer school courses in botany. During that period Professor Wetmore will continue the cytological investigations of the genera Aster and Soledago which he has been carrying on for some time. Dr. Woodworth will give attention to genetical and cytological studies with birches.

Dr. C. W. Dodge, curator of the Farlow Herbarium and Library, will spend the summer in Vermont, dividing his time between the manuscript of a book that he is writing on medical mycology and work on the mushroom flora of New England, undertaken by a committee of the Boston Mycological Club, of which he is chairman. Professor Roland Thaxter, of the Farlow Herbarium, will continue the preparation of drawings and manuscript for the next volume of his monograph of the Laboulbeniaceae, at his summer home in Kittery Point, Maine.

Professor M. L. Fernald, of the Gray Herbarium, accompanied on some trips by C. A. Weatherby, assistant at the herbarium, and on others by President A. S. Pease, of Amherst College, will visit localities in eastern America to study and collect little known plants. Ernst C. Abbe, graduate student, representing the Gray Herbarium, will join Noel E. Odell, a former lecturer on geology at Harvard University, as guests of Professor Alexander Forbes, in a scientific survey of the high Torngat Mountains about Ryan's Bay in northernmost Labrador. Dr. Lyman B. Smith, research fellow in botany, will continue, partly at the Gray Herbarium and partly in field work, his research for the Harvard Medical School on pollen flights and its relation to hay fever. He is collaborating with Dr. Francis M. Rackemann, instructor in medicine at the school.

SCIENTIFIC NOTES AND NEWS

DR. CHARLES FABRY, professor of physics at Paris; Dr. Emmanual de Margerie, professor of geology at Strasbourg, and Dr. Heinrich Wieland, professor of organic chemistry at Munich, have been elected foreign members of the Royal Society.

AT the meeting of the International Union for Scientific Investigation of Population Problems, held in London on June 15, Colonel Sir Charles Close, formerly director-general of the British Ordnance Survey, was elected president to succeed Professor Raymond Pearl, of the Johns Hopkins University. The next general assembly of the union will be held in Germany in 1934.

THE Electrochemical Society has awarded the Edward Goodrich Acheson Medal for 1931 to Dr. Edwin Fitch Northrup; it will be presented at the society's meeting in Salt Lake City on September 3. From 1903 to 1910 Dr. Northrup was secretary of the Leeds and Northrup Company, and from 1910 to 1920 assistant professor of physics at Princeton University. Since 1916 he has devoted himself chiefly to the development of high-frequency furnaces used for the melting of metals and alloys.

THE Pharmaceutical Society of Great Britain announces that the Hanbury Memorial Medal for 1931 has been awarded to Professor Hermann Thoms, of Berlin. The medal was founded in 1875 to commemorate Daniel Hanbury, a distinguished British pharmacist, and is awarded for "high excellence in the prosecution and promotion of original research in the chemistry and natural history of drugs" by a committee consisting of the presidents, for the time being, of the Chemical, Linnean and Pharmaceutical Societies, the chairman of the British Pharmaceutical Conference and one pharmaceutical chemist.

AT the commencement exercises of the College of

Wooster the honorary degree of doctor of science was conferred on Professor C. G. Williams, director of the Ohio Agricultural Experiment Station.

THE degree of D.C.L. has been conferred by the University of Durham on Dr. Robert Muir, professor of pathology at the University of Glasgow.

SIR SIDNEY F. HARMER, formerly director of the natural history departments of the British Museum, has been elected an honorary member of the French Zoological Society.

DR. HERMANN STIEVE, professor of anatomy at Halle, has been elected to membership in the Academy of Sciences at Upsala.

PROFESSOR W. H. HOFFMANN, of the Finlay Institute, Havana, has been elected a member of the International Leprosy Association.

DR. SAMUEL W. STRATTON, chairman of the corporation of the Massachusetts Institute of Technology, formerly director of the Bureau of Standards, celebrated his seventieth birthday on July 18.

DR. PETER MÜHLENS, professor of tropical medicine and hygiene at Hamburg, has been named professor *honoris causa* of the National University of Mexico.

DR. RUDOLF LADENBURG, of Berlin, has accepted an invitation to spend the next academic year at Princeton University.

DR. W. W. JAMESON, professor of public health in the London School of Hygiene and Tropical Medicine, has been appointed dean of the school, in succession to the late director, Sir Andrew Balfour.

DR. CECIL EDGAR TILLEY, of Emmanuel College, has been elected professor of mineralogy at the University of Cambridge.

DR. CARL VON FABER, director of the Buitenzorg Botanical Institute, Java, has been called to the University of Vienna.

DR. HERBERT F. PRYTHERCH was recently appointed director of the station of the Bureau of Fisheries at Beaufort, North Carolina, and aquatic biologist in charge of South Atlantic oyster investigations. In June, 1931, he received the degree of doctor of philosophy at the University of Pennsylvania after completing graduate research work under Dr. C. E. McClung.

DR. WILLIAM GERRY MORGAN, past president of the American Medical Association, and professor of gastro-enterology in Georgetown University School of Medicine for twenty years, has been appointed a member of the board of regents of the university.

DR. ALICE HAMILTON, assistant professor of industrial medicine at the School of Public Health of Harvard University, who recently received an Oberlaender Trust award, will study communicable occupational diseases in Germany.

THE Board of Scientific Directors of The Rockefeller Institute for Medical Research announces the following appointments on the scientific staff: *Associate,* Irvine Heinly Page; *Assistants,* Newell M. Bigelow, Albert Claude, J. Theodore Geiger, Harry S. N. Greene, Stanton A. Harris, John L. Jacobs, Esben Kirk, Douglas A. MacFadyen, David K. Miller, Ronald S. Saddington, Henry W. Scherp, Francis F. Schwentker, Wendell M. Stanley, Edward E. Terrell; *Fellows,* James H. Jensen, C. William Lacaillade, Jr., Ralph G. Schott, Lester W. Strock, John E. Stumberg, Peter S. Yang. The following promotions have been made: *Associate to Associate Member,* Oskar Seifried; *Assistant to Associate,* George P. Berry, Elmer E. Fleck, Thomas Francis, Jr., Raymond C. Parker, Robert E. Steiger.

DR. CHARLES A. WATERS, associate professor of roentgenology at the Johns Hopkins Medical School, and Mrs. Waters have sailed to participate in the third International Congress of Radiology in Switzerland.

DR. FRANCIS F. LUCAS, metallurgist of the research staff of the Bell Telephone Laboratories, was the recent guest lecturer of the Henry Marion Howe Memorial, delivered under the auspices of the American Institute of Mining and Metallurgical Engineers, Iron and Steel Division, at the Engineering Societies Building.

THE summer meeting of the American Astronomical Society will be held at the Perkins Observatory, Ohio Wesleyan University, Delaware, Ohio, on September 7, 8 and 9.

THE American Public Health Association will meet from September 14 to 17, in Montreal. Special sessions will be devoted to toxoid immunization, health education, training of personnel, rural sanitation and British public health administration.

AT the recent meeting of the American Society of Agronomy at Lafayette, Indiana, it was decided to hold the annual summer meeting at the University of Wisconsin in 1932. The present officers of the society are Dr. W. W. Burr, dean of the Nebraska College of Agriculture, Lincoln, *president,* and Dr. P. E. Brown, of the Iowa State College of Agriculture, Ames, *secretary.*

THE Second International Congress of Comparative Pathology will be held in Paris under the presidency of Professor C. Achard from October 14 to 18.

The subscription is 100 francs. Further information can be obtained from the General Secretary, M. C. Grollet, 7, Rue Gustave Nadaud, Paris, XVIe.

THE *British Medical Journal* reports that the Ninth Congress of the International Society of Surgery will be held in Madrid from March 15 to 18, 1932, under the presidency of Professor de Quervain, of Berne, with Professor Recasens, of Madrid, as vice-president. Delegates from Austria, Germany and Hungary will again attend this congress. The scientific program includes discussions on the diagnosis and treatment of intraspinal tumors, nontuberculous pulmonary suppuration, the surgery of the esophagus, and recent progress in the various forms of surgical anesthesia. It is proposed to arrange a tour starting from Irun on March 13, and visiting Madrid for the congress, thence proceeding to Toledo, Seville, Cordova, Granada, Valencia and Barcelona, with an excursion from the last-named to Monserrat. The inclusive cost of this tour will be just under 4,000 francs; inquiries should be addressed to L'Agence Belge de la Compagnie Française du Tourisme, 29, Boulevard Adolphe Max, Brussels. Further information about the congress will be supplied in due course by the general secretary, Dr. L. Mayer, 72, Rue de la Loi, Brussels.

ACCORDING to *Nature* the Museums Association held its annual conference this year at Plymouth from July 6 to 11. All meetings of the association were held in the Abbey Hall. July 6 was spent in committee meetings, and the president, Sir Henry Miers, delivered his presidential address on July 7. The president's address included some indication of a proposed survey of all the museums in the British Empire, to be financed by the Carnegie Corporation of New York. Among the papers read were: "A Suggested System of Museum Registration," by Mr. K. de B. Codrington, and "Paper for Museum Labels," by Dr. L. J. Spencer, on July 8; "Taxonomy in the Museum," by Dr. W. T. Calman, "Present-day Problems of Provincial Museums," by Mr. H. J. M. Maltby, and "The Preservation of Marine Life, Wet or Dry Specimens," by Dr. E. J. Allen, on July 9, and "Museum Problems in Canada," by Professor J. H. Iliffe, "A Simple Way to Test Museum Value," by Dr. Hay Murray, and "Why do we Use Plate-Glass in Museums?" by Mr. Frank Loney, on July 10. All communications concerning the conference should be addressed to the local honorary secretary, Mr. A. J. Caddie, Museum and Art Gallery and Cottonian Collection, Plymouth.

THE opening of the aviation wing of the New York Museum of Science and Industry was marked on July 13 at an informal luncheon in the aviation room. Officials and representatives of the technical press attended. Alexander Klemin, head of the Guggenheim School of Aeronautics of New York University and technical adviser on the aeronautics section of the museum, was toastmaster and Dr. Charles R. Richards, executive vice-president of the museum, outlined the general purposes of the industrial exposition. The luncheon was concluded with an informal discussion of the problems of the new section of the museum and a preview of the exhibits.

DR. VICTOR G. HEISER, director for the East of the International Health Board of the Rockefeller Foundation, conferred recently in Tokyo with Dr. Grand, of the foundation, and Dr. M. Miyajima, of the Kitasato Institute for Infectious Diseases, in regard to the endowment of a new school of Hygiene and Public Health in Tokyo. The following special organization committee has been appointed: *Advisers,* Dr. Hayashi, dean of the medical department of the Tokyo Imperial University; Dr. Kitajima, dean of the Keio Medical College, and Dr. Teusler, chief of St. Luke's International Hospital; *Chairman,* Mr. Akagi, chief of the Sanitary Bureau; *Commissioners,* Drs. Nagayo and Miyagawa, of the Imperial University of Tokyo, and the Government Institute for the Study of Infectious Diseases, Drs. Miyajima and Hata, of the Keio Medical College and the Kitasato Institute, Dr. Sato of St. Luke's International Hospital, and Drs. Kusama and Noheji, of the Sanitary Bureau of the Home Ministry.

THE will of the late Dr. John Osborne Polak, professor of obstetrics and gynecology at the Long Island College Hospital, leaves $350,000 to the hospital, $100,000 for the erection of a science laboratory and $250,000 for a building for private patients for maternity and gynecological cases.

ACCORDING to the *British Medical Journal,* on June 24 the Royal Society of Tropical Medicine and Hygiene, whose first president was Sir Patrick Manson, moved into its new home in the Manson House, 26, Portland Place, London. At present only the office and library are ready for occupation, but the other necessary alterations will be carried out as soon as possible, and a small hall for meetings is being erected at the rear of the building. As a result of the appeal issued last year by the president, Dr. G. Carmichael Low, and Sir Austen Chamberlain, nearly £12,000 has been raised, but a further £17,000 is required to equip Manson House as a suitable headquarters where fellows when on leave or visiting England can meet and discuss with those at home the problems of tropical medicine and hygiene. The society includes workers in tropical medicine in all

parts of the world, with representatives of all the well-known centers and schools of tropical medicine. Donations will be gratefully acknowledged by the president if sent to him at Manson House, 26, Portland Place, W.1.

THE Grenfell Association held a dinner at the Hotel Victoria, London, on July 2, when an appeal was made in aid of the endowment fund to carry on Sir Wilfred Grenfell's work in Labrador. Sir George Broadbridge, who presided, said that the funds necessary to maintain the schools and hospitals, industrial centers and agricultural stations which Sir Wilfred Grenfell had started had come almost entirely as the result of his own personal appeal on his lecturing tours. They felt that he should be relieved of the fatigue of these lecturing tours and so have greater freedom for the increasing claims of Labrador. The supporters of his work in Canada, Newfoundland and the United States had raised an endowment fund of £120,000, and it was hoped to raise a sum in Great Britain worthy of the man and his work. Their aim was to secure at least £50,000 within the next three years as a fitting tribute to the life work of one of the most remarkable Englishmen of his day in the oldest British possession overseas.

THE General Assembly of Tennessee, the session of 1931, passed an act authorizing the Fish and Game Commission, which has jurisdiction and control of the lands and property on the shores of Reelfoot Lake, to set apart for the Tennessee Academy of Science some suitable building and such amount of lands adjacent to the Lake, not exceeding ten acres, for the establishment of a biological station for carrying on research work, the property and building to be under the management and control of the Academy of Science without the payment of rent or other payment to the state. The General Assembly also made an appropriation of $2,500 to be expended out of the Fish and Game Fund and rentals for state property around Reelfoot Lake by the Department of Fish and Game, under the commissioner of agriculture, for necessary buildings, plant outfit and grounds for the biological station.

DISCUSSION

THE BASIC SCIENCES AT THE CHICAGO CENTENNIAL EXPOSITION, 1933

THE city of Chicago having been incorporated as a village in 1833, a group of its leading citizens decided, some two or three years ago, to celebrate the centennial of this event by holding an international exposition. This decision, however, was arrived at only after this group of gentlemen were thoroughly satisfied that they had a theme for an exposition which would make it not a mere repetition of other exhibitions, but a center to which people might come and discover for themselves a new view-point, a changed state of affairs. This theme was found in the ministrations of pure science to industry and to society. The dependence of commerce and manufactures upon the results obtained in laboratories of science was considered a fascinating story, and something worthy of celebration. The change from the covered wagon to the Pullman car, the substitution of the air-plane for the pony express, the increased leisure and the higher plane of living, all of which came in the wake of these advances in science, combine to make the story a fitting theme for a world's fair.

The achievements of pure science having been adopted as the central motive of the exposition, the president, Mr. Rufus C. Dawes, promptly invited the National Research Council to suggest what line of scientific results might best be shown in order to demonstrate this principal thesis of the fair. The response to this invitation was generous. It took form in the appointment of an advisory committee and various subcommittees whose reports are now guiding the spirit and the arrangement of the exhibits in the field of pure science.

The division of basic sciences falls in the department of exhibits and, for convenience of operation, is subdivided into five sections as follows:

Division of Basic Sciences
1—Astronomy
2—Physics and mathematics
3—Chemistry
4—Biology, including psychology
5—Earth Sciences, including geology, geography and geodesy

Anthropology and psychology, each of them a biological science, will be grouped together as they are in the organization of the National Research Council; but they will probably be shown in a building other than the hall of the basic sciences. This separation is a mere matter of convenience in securing the proper space for these two large fields of investigation.

In presenting the basic sciences to the visitors of 1933, the plan of the administration is to forget questions of nationality and to make the entire exhibit thoroughly cosmopolitan and international. The important discoveries in each science are to be set forth in their proper sequence regardless of the places where and the men by whom they were made. Easily read legends will set forth not only the fundamental idea of each exhibit but also, in many cases, our indebtedness to the individual investigator.

Another distinct feature will be the presentation of phenomena and processes of the basic sciences, rather than mere apparatus or even results which have been obtained by use of apparatus. That this is no simple undertaking will be evident to every one. To demonstrate, on the lecture table, a chemical reaction in the presence of a class is one thing; to maintain this process in continuous operation for one hundred and fifty days is quite another thing. To demonstrate the phenomena involved in some vital process in the laboratory, perhaps on the stage of a microscope, for a few minutes, is one thing; to keep the phenomena visible to a large number of visitors for a period of five months is something quite different. To what extent these dynamic exhibitions can be substituted for the static ones so largely employed hitherto must be left for the future to decide. Whatever is possible in this direction will be achieved largely by the aid of clever, generous and wise advice from various leaders of science who have in the past so freely given valuable suggestions and help.

The inherent difficulty of making clear an intellectual advance by purely material means, plus a few printed legends, is something which needs only to be stated in order to be appreciated. Curiously enough, exposition becomes especially arduous in those very fields, such as algebra and quantitative physics, which lend themselves so readily to description in mathematical symbols. Since the main goal of the Chicago Centennial is a demonstration of the indebtedness of society to science, nothing in the way of a stated course in science will be offered; on the other hand, it is hoped that the exhibits, even in the pure sciences, will furnish entertainment and inspiration as well as instruction.

The Department of Exhibits, which is under the direction of Mr. John S. Sewell, includes besides the basic sciences six other divisions, namely those of applied science, of which Mr. J. F. Bell is the chief; agriculture, in charge of Mr. Harvey J. Sconce; social science, at the head of which is Professor H. W. Odum; state and federal participation, in charge of Mr. C. Van Deventer; foreign participation, at the head of which is Mr. Felix J. Streyckmans; and fine arts, which has not yet been organized. The entire executive responsibility of the fair has been placed upon Mr. Lenox R. Lohr, who is manager of the exposition; but responsibility for the preparation and installation of exhibits in the basic sciences is in the hands of the following: chief of division, Professor Henry Crew; associate in astronomy, Professor Philip Fox; associate in physics and mathematics, Dr. Gordon S. Fulcher; associate in chemistry, Dr. Irving Muskat; associate in biology, Mr. J. F. W. Pearson; associate in geology, Professor J. V. Lewis.

The plans of the division of the basic sciences include also the publication of a series of small volumes devoted to the latest phases of some twenty branches of science, pure and applied. The authors are well-known scholars. The series will be handled by the Waverly Press, Williams and Wilkins.

Readers of SCIENCE have already learned that the American Association for the Advancement of Science will hold its summer meeting for 1933 in Chicago. A considerable number of foreign scholars in each section of the association are being invited for this occasion.

JOHN STEPHEN SEWELL,
Director of Exhibits

THE WORK OF CHINESE BOTANISTS ON THE FLORA OF CHINA

IT is interesting to note the efforts that the younger generation of Chinese botanists are devoting to the further elucidation of the very rich and complex flora of China. This work by Chinese botanists under the auspices of Chinese institutions has been developed within the last two decades. There has recently been issued under the joint auspices of the Metropolitan Museum of Natural History, Nanking, and the Fan Memorial Institute of Biology, Peiping, an important contribution to our knowledge of the fern flora of China.[1] The volume is large quarto in size, and contains full descriptions in English and in Chinese, and illustrations, of fifty-one species of Chinese ferns, including a number recently described as new by Mr. Ching. The format, typography and press work is good. The very excellent illustrations showing both macroscopic and microscopic characters renders this publication particularly useful to those interested in the study of Chinese ferns. This important work deserves a place in every botanical library.

E. D. MERRILL

NEW YORK BOTANICAL GARDEN,
NEW YORK, N. Y.

EXPONENTS AND FOOTNOTES

THE writer has long wondered whether an alternative could not be devised for the now very general practice of applying Arabic numerals to footnotes, and indicating their place of reference in the text by numbers typographically identical with those employed as exponents. In a vast majority of cases, of course, no confusion results from this procedure. Either no mathematical formulae are present in a paper, or the context makes it evident, in a given case, whether or not we have to do with an exponent. But in some instances this is not true. Exponent

[1] H. H. Hu and R. C. Ching, "Icones filicum sinicarum," Fasc. 1, p. 1–102, pl. 1–50, 1930.

and footnote reference numbers may occur together on adjacent lines, set in the same type, and having approximately the same magnitudes. (I have just such a case before me in a recent issue of an important journal.)

Until a few months ago, however, this danger of confusion was, in my own case, rather an academic possibility than an actual experience. But it was realized in a rather disastrous way in a recent scientific paper of mine. On one page of this paper[1] occur two footnotes (numbered 1 and 2), likewise two fractions bearing exponents. The first of these, which should have been $(\frac{4}{5})^3$, has been printed $(\frac{4}{5})^1$. The second, which should have been $(\frac{5}{6})^4$, actually reads $(\frac{5}{6})^2$. These typographical errors result not only in errors of elementary arithmetic, but they render unintelligible the discussion of a rather important phase of my subject, both on this and later pages of the text. The source of these errors, on the printer's part, seems obvious.

Is it unreasonable for me to suggest that reference numbers (or letters) to footnotes should be set in entirely different type from those employed as exponents?

F. B. SUMNER

SCRIPPS INSTITUTION OF OCEANOGRAPHY

COLOR

BY some mistake which neither the editor nor I can explain, the last part of my note on "Color" in SCIENCE for May 8, p. 495, was omitted. The portion omitted follows:

(6) If the physiological elements in the retina which respond to red light are missing, the phenomenon ends here and the sensation of red is not excited.

(7) If the eye is normal, the sensation is transmitted to the brain and mind by a process still entirely physical or chemical but evidently quite different from that by which the light has been transmitted to the eye.

(8) In the brain and mind the sensation of red is produced. Some think the phenomenon is still physical or chemical, but no one has been able to suggest any definite picture of the processes in the mind as physical phenomena.

(9) The name given to the sensation depends on previous comparisons which the individual has made with the aid of others. If he is an American he will call the sensation red. A Frenchman will call it rouge; a German, roth.

It is evident, therefore, that color is a complex phenomenon including many diverse elements no one of which can be omitted if the phenomenon is complete.

Durant in his "History of Philosophy" defines philosophy as "the synthetic interpretation of all experience" and seems to wish to delimit science as including only analysis and description. Most scientific men will agree, I think, that science which includes only analysis and description is of a low order. To be of much value it must rise above that to coordination and synthesis. In these higher reaches science and philosophy should become identical.

What has been given above may be called a scientific philosophy of color.

W. A. NOYES

HEIDELBERG, JUNE 11, 1931

SPECIAL CORRESPONDENCE

GRANTS-IN-AID OF THE NATIONAL RESEARCH COUNCIL

AT its meeting in June the National Research Council's Committee on Grants-in-Aid made grants for the support of research as follows:

To Charles W. Jarvis, associate professor of physics, Ohio Wesleyan University, critical potentials of mercury vapor; C. E. Mendenhall, professor of physics, University of Wisconsin, photoelectric characteristics of metals; S. A. Mitchell, director, Leander McCormick Observatory, University of Virginia, the measurement of the proper motion of the stars for the determination of parallax; Louis A. Turner, associate professor of physics, Princeton University, temperature distribution and metastability of vibration and rotation states of iodine molecules; Peter I. Wold, professor of physics, Union College, electrical properties of expanded mercury, with special reference to the Hall effect and to conductivity.

To Gleason W. Kenrick, assistant professor of electrical engineering, Tufts College, statistical study of field intensities in the low frequency region of the radio spectrum.

To Wilder D. Bancroft, World War Memorial professor of physical chemistry, Cornell University, the application of physical chemistry and colloid chemistry to biological and medical problems; Harry N. Holmes, professor of chemistry, Oberlin College, concentration of vitamin A and other vitamins.

To Arthur Keith, geologist, United States Geologi-

[1] *Journal of Genetics*, November, 1930, p. 307. Barring these unfortunate, but easily comprehensible errors, the press-work was exceptionally fine.

cal Survey, investigations of portions of northern Maine and of New Brunswick to determine the existence of two periods of mountain building; Lewis B. Kellum, assistant professor of geology, University of Michigan, reconnaissance of a belt of cross-folding in the Sierra Madre mountains of Mexico; K. C. McMurry, associate professor of geography, University of Michigan, land survey of Isle Royale; Jerome S. Smiser, instructor, department of geology, Princeton University, collection and description of the echinoids in the Cretaceous rocks of the Big Bend Trans Pecos, Texas; H. B. Stenzel, assistant professor of geology, Agricultural and Mechanical College of Texas, the paleontology and stratigraphy of the Lower Claiborne group in Leon County, Texas; Stephen Taber, professor of geology and mineralogy, University of South Carolina, structural geology of the land areas adjacent to the Bartlett trough.

To Morris G. Leikind, School of Hygiene and Public Health, Johns Hopkins University, lymphocystic disease of fish; Clarence A. Mills, professor of experimental medicine, University of Cincinnati, temperature adaptation in animals; William C. Rose, professor of physiological chemistry, University of Illinois, nutritive importance of the amino acids; Leo T. Samuels, assistant professor of biological chemistry, and Howard A. Ball, instructor in pathology, College of Medical Evangelists, the relationship between the hypophysis and the growth of autogenous and transplanted malignant tumors in animals; Charles W. Turner, associate professor of dairy husbandry, University of Missouri, the hormone of lactation of the anterior pituitary; George D. Williams, assistant professor of anatomy, Washington University, accurate determination of skin color.

To Bennet M. Allen, professor of zoology, University of California at Los Angeles, the influence of the thyroid gland and hypophysis upon growth and development; L. R. Cleveland, assistant professor of protozoology, Harvard Medical School, phylogenetic relationships of the intestinal protozoan parasites of termites and other primitive insects; Ernst Gellhorn, associate professor of physiology, University of Oregon, comparative physiology of ion antagonism and ion effects in fatigued muscles; LaDema Mary Langdon, assistant professor of biology, Goucher College, comparative study of the embryogeny of Juglandaceae and Fagaceae; Manley L. Natland, Long Beach, California, ecological conditions of foraminifera and mollusca; Will Scott, professor of zoology, University of Indiana, distribution of the finger nail clams of Indiana; Paul B. Sears, professor of botany, University of Oklahoma, pollen analysis of Arkansas peats.

To Sophie de Aberle, instructor in anthropology and obstetrics, Institute of Human Relations, Yale University, growth and development in Indian children in New Mexico and Arizona; William R. Morse, dean of the College of Medicine and Dentistry, West China Union University, Chengtu, West China (at present at the Peabody Museum, Harvard University), anthropology of the inhabitants of the Province of Szechwan, West China; Elsie Murray, instructor in psychology, Cornell University, partial color-blindness; Jessie W. Murray, acting director, Tioga Point Museum, investigations of aboriginal Indian sites near Athens, Pennsylvania; E. Sapir, professor of anthropology and general linguistics, University of Chicago, the collection of the songs of the Nitinat Indians of Vancouver Island.

VERNON KELLOGG,
Permanent Secretary,
National Research Council

SOCIETIES AND MEETINGS

THE TEXAS ACADEMY OF SCIENCE

THE Texas Academy of Science held its spring meeting at Austin on June 5, where it was the guest of the Faculty Science Club. The occasion for this meeting was the conferring of life fellowship upon those who remained of the group of men who founded the academy on January 9, 1892. The session began on Friday afternoon with an inspection of the various laboratories and collections of the university. The visiting chemists were given a "preview" of the new chemistry building, which when completed will be one of the finest in the South. The various collections belonging to biology, botany, geology and anthropology drew their quota of visitors. At 7 P. M. a dinner was served at the University Commons to one hundred and twenty-five members and guests. The program which followed consisted of a greeting to the academy from the president of the university, Dr. H. Y. Benedict, who also represented the Faculty Science Club. Dr. F. W. Simonds gave a history of the first ten years' work of the academy, which told of the struggles to gain for it the recognition of the scientific world.

J. Kern Strecker, president of the Texas Academy of Science, presented certificates of life membership to the following members: J. R. Bailey, professor of organic chemistry, University of Texas; H. Y. Benedict, president, University of Texas; James T. Clark,

Texas Land Office; A. Judson, M.D., Houston, Texas; F. W. Simonds, professor of geology, University of Texas, and R. A. Thompson, highway engineer, Dallas. In presenting these certificates, President Strecker gave a history of each recipient, and stated that of the fourteen men who on January 9, 1892, founded the academy, six were dead, the whereabouts of one unknown and the remaining seven were present. The responses to the president's presentation speech were much appreciated by those present. Dr. H. Y. Benedict expressed the hope that, as one half of the original founders were present at the fortieth anniversary, one half of those who reorganized the academy would be present at the eightieth anniversary.

The secretary, H. B. Parks, San Antonio, gave a short résumé of the accomplishments of the past three years and the plans for the work of the immediate future.

The lecture of the evening consisted of a talk by Dr. J. M. Kuehne on colored photography, which was illustrated by some two hundred slides. The colored photographs told the story of the wild flowers of Texas through a single season, beginning with winter and spring flowers and ending with the composites of the autumn. Of special interest were the photographs of species that are common in Texas in early spring, which were blooming along the edge of the snow-cap of Mt. Rainier in August.

A meeting of the executive committee at the close of the program selected Dr. F. McAllister to represent the academy at the Pasadena meeting of the American Association for the Advancement of Science.

H. B. PARKS,
Secretary

THE NEW HAMPSHIRE ACADEMY OF SCIENCE

THE annual meeting of the New Hampshire Academy of Science was held May 29 and 30, 1931, at Littleton, New Hampshire.

On Friday night, May 29, the academy was addressed by Mr. Arthur H. Norton, curator of the Portland Society of Natural History, on "Shore Mammals of Northern New England." Slides showing specimens and illustrations collected by Mr. Norton in his many years of work with the shore fauna of northern New England were shown.

On Saturday morning, May 30, Mr. Henry Helm Clayton, formerly of the Argentine Weather Bureau and the Smithsonian Institution, now consulting meteorologist, gave an address on "Long Range Weather Forecasting from Variations in Solar Heat," illustrated by graphs and charts. Papers by members of the academy were read and discussed at the remainder of the morning session.

The afternoon was given over to an excursion to the new power plant and dam of the Grafton Power Company at the Fifteen Mile Falls on the Connecticut River, about twelve miles from Littleton. This hydro-electric project, developing 250,000 horse power, is the second largest in New England, and has just gone into operation.

After the business meeting on Saturday night, the retiring president, Dr. C. H. Dolloff, delivered the presidential address, "The Present Status of Psychiatry," after which the papers by the members remaining on the program were read and discussed.

At the business meeting, among other matters, the academy voted to have the executive council consider the project of a junior academy of science.

Officers for 1931–1932 elected were:

President, Professor James W. Goldthwait, geology department, Dartmouth College.

Vice-president, Professor Norman M. Gilbert, physics department, Dartmouth College.

Secretary-Treasurer, Professor George W. White, geology department, University of New Hampshire.

Member of the Executive Council, Dr. Charles H. Dolloff, Superintendent, New Hampshire State Hospital.

GEO. W. WHITE,
Secretary-Treasurer

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE GRINDER FOR SOFT TISSUES

THE tissue grinders now available are subject to one or more of the following disadvantages: (1) they are so expensive that most laboratories can not stock them in quantity; (2) they must be sterilized immediately before using, so that much time is lost between the removal of the tissue and its grinding; (3) there is danger of contaminating the tissue from the air or from the hands of the worker, and (4) danger to the worker from contact with infected tissue. In the commonly used mortar and pestle the last two disadvantages are especially marked. For some years we have been using a type of grinder, not subject to these disadvantages, which may be useful to other laboratory workers.

The suggestion for the grinder came from Hagan,[1] who used two test-tubes that fitted one into another.

[1] W. A. Hagan, *J. Exp. Med.*, 36: 722, 1922.

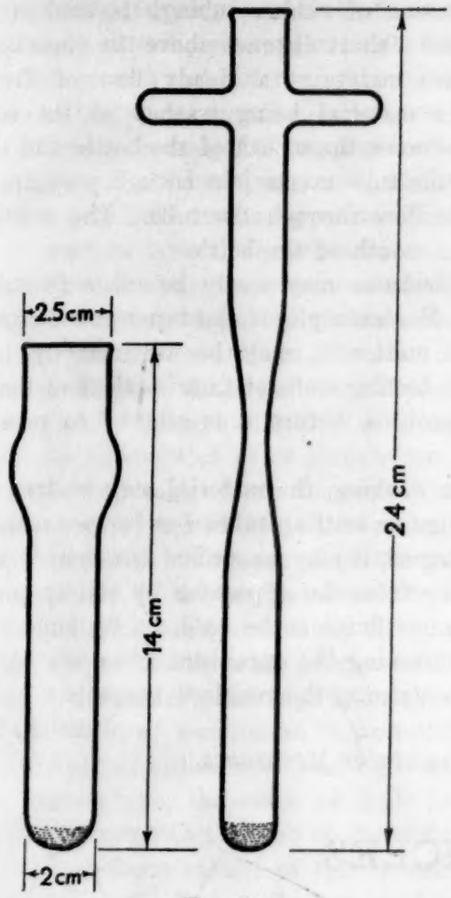


FIG. 1

We have modified it as shown in the sketch (Fig. 1) and have had it made of Pyrex glass to decrease the danger of breakage. A bulb holds the ground tissue and the salt solution used for suspending it. The plunger, which has been lengthened to prevent contamination of the top of the tube, has also been constricted to make the introduction of fluids easier. The projections on the top of the plunger make handles that can be easily grasped. The plunger must fit the inner side of the tube snugly but not so tightly as in a syringe. The bottom of the plunger is ground to fit the tube accurately, and the two should be numbered so that they can always be matched. The dimensions given are those we have found useful, but they may be modified according to the amount of tissue usually ground.

Since these grinders, when made in small quantities, cost about three dollars, a number can be kept on hand ready for use. The outer tube and plunger are sterilized separately; the former is plugged and capped, while the latter is inserted up to the cross pieces in a large plugged test-tube. The outer tube is then ready to receive tissue from an autopsy, and when convenient the sterile plunger can be inserted and the tissue ground. Salt solution or other diluent may be introduced with a pipette. The danger of contaminating the tissue or the hands of the worker is slight.

Since this grinder operates largely by pressure, organs containing much connective tissue can not be readily emulsified in it. Soft tissues, such as rabbit or guinea-pig spleen, liver, or brain, can, however, be rapidly ground to such a fine state that when diluted with an equal amount of salt solution they will pass through a No. 20 needle. It is sometimes necessary to remove coarse particles, which would plug the needle, by slow centrifugation. Cultures for bacterial counts or to secure isolated colonies from infected material can be made from the emulsions.

Recently we have found these grinders very useful for preparing chick embryo emulsions to be used in the Li-Rivers' method[2] of cultivating filtrable viruses, and for the preparation of uniform emulsions of dried tissues containing viruses.

CARL TENBROECK

DEPARTMENT OF ANIMAL PATHOLOGY,
THE ROCKEFELLER INSTITUTE FOR
MEDICAL RESEARCH,
PRINCETON, NEW JERSEY

A SIMPLE APPARATUS FOR WASHING PROTOZOA

A SIMPLE method of washing Protozoa and other small objects in running water has proved so satisfactory in my own work that I believe other investigators may also find it useful. Its chief virtue lies in its simplicity.

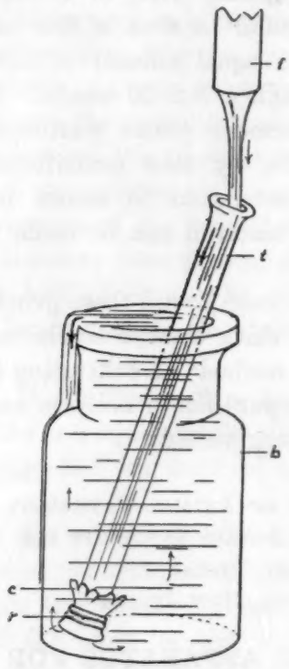
The apparatus described below is a modification of that used by Caullery and Chapellier as given by Langeron.[1] All that is needed is a section of glass tubing of convenient size, a scrap of bolting cloth, a rubber band and a bottle. The accompanying diagram will illustrate the set-up. A section of glass tubing (t) about 8 cm long and 5 or 6 mm inside diameter is heated at one or both ends and spread slightly after the manner of the bulb end of an ordinary pipette. A piece of bolting cloth (c) is tightly fastened over an enlarged end of the tube by means of a rubber band (r). No. 20 silk bolting cloth has proved quite satisfactory for average size Protozoa, while No. 25 serves for the smaller forms. This procedure is probably not suitable for the very smallest organisms.

The tube is placed, covered-end down, in a small bottle (b) of a size and shape that will allow the tube to extend well above the mouth, and provide a reasonably steady base. The organisms to be washed are placed in the tube by means of a pipette. As soon as the fluid has drained from the tube into the

[2] C. P. Li and T. M. Rivers, *J. Med. Exp.*, 52: 465, 1930.

[1] M. Langeron, "Précis de Microscopie," Maison et Cie., Paris, 1925.

bottle a small stream of water is allowed to flow into the tube, directly from the faucet (f) if the bottle can be placed within a few centimeters of it, or via an extension of rubber tubing, the end of which is supported a short distance above the glass tube. This procedure maintains a steady flow of fresh water over the material being washed as the column of water between the mouth of the bottle and the upper end of the tube exerts just enough pressure to cause a gentle flow through the tube. The waste escapes over the mouth of the bottle.



Modifications may easily be made to suit special needs. For example, if the tap water contains much foreign matter it may be strained by leading it through bolting cloth of finer mesh than that holding the organisms, before it is allowed to pass into the tube.

After washing, the material may be transferred to centrifuge or settling tubes for further manipulation. If preferred, it may be stained and dehydrated before removing from the apparatus by merely pipetting in the various fluids to be used, or by transferring the tube containing the organisms from one bottle to another containing the required reagents.

JOHN P. TURNER

UNIVERSITY OF MINNESOTA

SPECIAL ARTICLES

X-RADIATION AND REGENERATION IN AMBLYSTOMA

IT has been demonstrated within the past few years, especially by the work of Curtis[1] and his students, that x-radiation affects very markedly the regenerative activity in certain invertebrates. Coelenterates, planarians and annelids, for example, which under normal conditions readily regenerate lost parts, lose their capacity for regeneration when subjected to the influence of x-rays. Although considerable work has been done on the influence of x-radiation on regeneration in invertebrates, so far as the writer is aware no observations have been published on the effects of x-rays on the regenerative activity in vertebrates.

During the past two years the writer has conducted a series of experiments which deal with the effects of x-radiation on regeneration in embryos of Amblystoma, especially on regeneration of the fore limb. The fore limb of this animal is a convenient structure for use in experimental studies on regeneration, for the reason that under ordinary conditions it is very readily regenerated, and in embryonic stages of Amblystoma the regeneration takes place rather rapidly. The results of all experiments to date show conclusively that x-radiation in proper dosage will prevent normal regeneration of the limb in any stage of limb development.

When the limb bud is amputated at a very early stage of development, the amputation consists in the removal of merely the small mesodermal bud and its ectodermal covering. The wound heals quickly and, under normal conditions, regeneration of the limb bud and subsequent normal limb development takes place. However, the limb will fail to regenerate after amputation, if the embryo be given daily dosages of x-rays. Some growth takes place and a short spur-like appendage develops; but differentiation into upper arm, forearm and hand does not occur. Radiation appears to prevent differentiation during regenerative growth.

It is especially striking that a dosage of x-radiation which very definitely prevents limb regeneration has no apparent effect on normal limb growth and differentiation. If, for example, the limb bud on one side of the body is amputated at an early stage of limb development, and the embryo is radiated daily, the limb will fail to regenerate except for the development of a short spur-like appendage. In the same embryo, however, the unharmed limb bud on the opposite side of the body will grow and develop into a normal limb, apparently unaffected by the radiation. Other experiments, also, demonstrate this same phenomenon. For example, daily radiation of Amblystoma embryos has been begun in the blastula

[1] W. C. Curtis, "Old Problems and a New Technique," SCIENCE, 67: 141–149, 1928.

stage and continued during a period of over seven weeks. Embryos so radiated appear to develop normally, and limb growth and differentiation takes place in an apparently typical manner. However, if at any time during the course of the experiment a limb is amputated, it will not be regenerated; at the same time the unharmed limb on the opposite side of the embryo will continue normal development.

By means of x-radiation, regeneration can be as effectively prevented in late stages of limb development as in early stages. If an embryo, the fore limb of which is well developed into upper arm, fore arm and hand, be given daily dosages of x-rays no portion of the limb will be regenerated after amputation. This failure to regenerate under the influence of x-radiation occurs, moreover, regardless of the level at which the limb is amputated. The wound at the point of amputation heals as quickly as in normal unradiated controls, and there is a slight amount of growth at the cut end. However, there is no regeneration of the lost part such as takes place rapidly in unradiated embryos. The effect of x-radiation in preventing regeneration, therefore, appears to bear no relation to the age of the embryo, the stage of limb development, or the level at which the limb is amputated.

One of the significant results of this investigation is that x-radiation affords a method of studying experimentally the differentiation process in regeneration as compared with differentiation in normal embryonic development. It would appear that the differentiation during regeneration is in some important respect unlike the differentiation during normal development; the former is prohibited by a dosage of x-radiation that has no externally visible effect on the latter. Histological studies of non-regenerating limbs of Amblystoma embryos compared with normally regenerating limbs are now in progress.

The source of radiation for these experiments was a Coolidge medium focus tube. The factors governing the dosage of radiation were as follows: 65 kilovolts, 7 milliamperes, distance from target to embryo 25 cm., exposure from 3 to 5 minutes.

ELMER G. BUTLER
LABORATORY OF COMPARATIVE ANATOMY,
PRINCETON UNIVERSITY

EFFECTS ON THE GONADS OF CORTICO-ADRENAL EXTRACT[1]

AN apparent interrelationship between the adrenal cortex and the sex glands has frequently been noted by clinicians.[2,3] The fact that both tissues arise from a common mesodermal origin, and that hypertrophy of the adrenal cortex occurs in pregnancy and in sexual precocity, has strengthened this view. No adequate experimental evidence in confirmation of the hypothesis appears, however, to have been brought forward.

In an attempt to secure data relative to this possible interrelationship, immature albino rats were injected intraperitoneally with cortico-adrenal extract prepared in this laboratory according to the method of Swingle and Pfiffner.[4] This extract has been shown to contain the cortical hormone in sufficient amount to maintain adrenalectomized cats in good health for considerable periods of time, and to revive animals showing marked symptoms of adrenal insufficiency.[5] Litter mates which were used as controls were injected with corresponding amounts of normal saline solution. All animals used were of Wistar stock. They were fed on a standard meal diet.

Following one and two-week periods of treatment, the animals were killed and the gonads fixed in Bouin's solution. Identical methods of fixation, clearing and staining were employed in order that the observations might be in every way comparable. The results of the treatment are summarized in the accompanying table.

When histological preparations of the gonads were compared in all animals from the 25-day stage onward, it was observed that maturation of the experimental gonad, considerably beyond that seen in controls of the same age, had taken place. In the female this was evidenced by a greater amount of fluid within the follicles, and by increased follicular diameter. In the male, the difference was not so striking. The tubules of the experimental animals presented a more closely packed appearance, and a reduction and increased differentiation in the cells of the germinal epithelium was apparent. The general appearance was quite similar to that seen in young rats, following the injection of macerated pituitary gland.[6] The cortico-adrenal extract used, it should be mentioned, was in all cases sterile and protein free, and contained approximately 1 in 4,000,000 parts of adrenalin.

In several cases marked uterine enlargement was produced by cortico-adrenal extract injection. The

[1] Reported in brief at the meeting of the Federation of American Societies for Experimental Biology, Montreal, April 11, 1931.

Grateful acknowledgment is made of aid in the above investigations by the Grants-in-aid Committee of the National Research Council.

[2] W. Bullock and J. Segueira, *Trans.* Path. Soc. London, 56: 189, 1905.

[3] L. Guthrie and W. d'E. Emery, *Trans.* Clin. Soc. London, 40: 175, 1907.

[4] W. W. Swingle and J. J. Pfiffner, *Anat. Rec.*, 44: 225, 1929; *Am. Jour. Physiol.*, 95: 153, 164, 1931.

[5] S. W. Britton and Herbert Silvette, SCIENCE, 73: 322, 373, 1931.

[6] E. L. Corey, *Physiol. Zool.*, 3: 379, 1930.

Number of animals used	Age (days)	Daily dosage	Equivalent in fresh glandular substance (grams)	Duration of period of injection	Results in experimental animals*
4	18	½ cc	7.5	1 wk. (2)	Negative
				2 wks. (2)	"
4	20	2 cc	60.0	1 wk. (2)	"
				2 wks. (2)	"
4	25	½ cc	15.0	1 wk. (2)	"
				2 wks. (2)	"
4	32	¼ cc	7.5	1 wk. (2)	"
				2 wks. (2)	Corpora lutea present.
4	33	4 cc	120.0	1 wk. (4)	Corpora lutea present.
4	35	1 cc	30.0	1 wk. (4)	Spermatogenesis. Corpora lutea.
2	42	1 cc	30.0	1 wk. (2)	Spermatogenesis. Corpora lutea.

* Corpora lutea were present in none of the control animals. At the 42-day stage, however, a small percentage of the tubules of the controls contained a few spermatozoa.

pituitary gland also showed considerable hypertrophy in some of the youngest animals examined.

It is concluded that extracts of the adrenal cortex, which contain according to recent observations the hormone of the cortical tissues, produce precocious sexual maturity in the albino rat. The effect is most pronounced and first produced in the female.

E. L. COREY
S. W. BRITTON

PHYSIOLOGICAL LABORATORY,
UNIVERSITY OF VIRGINIA

ANTIUREASE[1]

ANTIENZYMES, such as antirennin, antipepsin, antitrypsin, anticatalase, antiemulsin, antiamylase and others, have been described in enzyme literature, but there always has been considerable doubt of their existence. In some cases, as with anticatalase, the substance is nothing more than an inhibitor occurring naturally in animal tissues. The production of antipepsin by injecting pepsin into animals is very improbable since pepsin is rapidly destroyed at the pH of the blood.

We believed that crystalline urease would be especially suitable for the production of an antiurease in animals for the following reasons: It is extraordinarily active; it is stabilized by blood serum and it poisons animals even in small doses by converting the animal's urea to ammonium carbonate.

Urease, recrystallized from 30 per cent. alcohol and of the highest obtainable activity, was injected into young rabbits of from 2 to 2½ kilograms in weight. When given by ear vein as little as 0.3 mg caused convulsions after a few minutes and death after 1 or 2 hours. When the urease was injected intraperitoneally the rabbit was usually found dead in 10 to 12 hours. Subcutaneous injection caused death within 36 to 48 hours. It has been possible to immunize rabbits by starting with subcutaneous, or intraperitoneal injections of 0.02 to 0.04 mg and increasing the dose gradually. The amount of urease has been increased as high as 4 or 5 mg of crystalline urease at a single injection without causing any loss in weight and any visible symptoms other than slight swellings at the sites of injection. Serum from these immunized rabbits, when incubated with crystalline urease, greatly inhibits the ability of the urease to hydrolyze urea. Even as little as 0.015 cc of the immune serum has an unmistakable effect. When normal rabbits are given protective doses of immune serum intraperitoneally, they have been shown to be unaffected by twice the lethal dose of crystalline urease.

Since antiurease can be determined easily by chemical means and, unlike toxin-antitoxin, is independent of animal experimentation for its demonstration and estimation, we expect this work to lead eventually to a more complete understanding of the phenomena of immunological reactions.

JAMES B. SUMNER
J. STANLEY KIRK

[1] From the Department of Physiology and Biochemistry, Medical College, Cornell University, Ithaca.

BOOKS RECEIVED

BROWNELL, HERBERT. *Physical Science.* Pp. xiv + 313. 125 figures. McGraw-Hill. $2.50.

JONES, HENRY A. and SAMUEL L. EMSWELLER. *The Vegetable Industry.* Pp. viii + 431. 154 figures. McGraw-Hill. $2.25.

MILLARD, E. B. *Physical Chemistry for Colleges.* Third edition. Pp. ix + 522. 87 figures. McGraw-Hill. $3.75.

NATIONAL RESEARCH COUNCIL OF JAPAN. *Japanese Journal of Geology and Geography.* Transactions and Abstracts. Volume VIII. No. 4. Pp. ii + 241 + 359. Illustrated. The Council, Tokyo.

SHIRLEY, MARY M. *The First Two Years; a Study of Twenty-Five Babies.* Volume I. Postural and Locomotor Development. Pp. xv + 227. 15 figures. 10 plates. University of Minnesota Press. $2.00.

TING, V. K. and Y. C. SUN, editors. *Palaeontologia Sinica.* Series D; Volume VII; Fascicle ii: On an Adolescent Skull of Sinanthropus Pekinensis in Comparison with an Adult Skull of the Same Species and with Other Hominid Skulls, Recent and Fossil, by Davidson Black. Pp. 144 + viii. 16 plates. 37 figures. The Geological Survey of China, Peking.

YONGE, C. M. *A Year on the Great Barrier Reef.* Pp. xx + 246. 69 plates. 17 diagrams. Putnam. $6.00.